Long-term rice straw incorporation: does it impact maximum yield?

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Introduction

Rice growers have faced a decade of reinventing some of the aspects of growing rice. Passage of the California Rice Straw Burning Reduction Act (AB 1378) in 1991 forced growers to contend with a tremendous amount of rice residue that was usually burned. The burning of the residue serves many functions, including reducing the incidence of weeds and pathogens and to facilitate seedbed preparation. There were basically two choices for rice growers to deal with the rice residue, either leaving in the field or removal. Many variations of leaving the residue in the field have been explored, ranging from incorporation by tillage or cage rolling to leaving it on the surface. The in-field approaches were thought to potentially immobilize nutrients leading to possible yield declines. Long-term results have shown that winter flooding increases available soil N and leads to a significant yield gain over non-winter flooded fields regardless of the type of residue management employed. However, the response is higher on soils with higher clay or organic matter content. In addition, an additional yield gain is seen in fields with a minimum of 3 to 5 years of straw incorporation compared to where straw is burned or removed. These findings suggest that fertilizer rates can be reduced by 50lbs N/A depending on soil type, residue management and use of winter flooding.

Though the N story is fairly complete, as fertilizer N additions and straw incorporation reaches maximum yield potential at 100 lbs N/acre, the burned treatment continues to rise with increasing fertilizer N addition. These results suggest that straw incorporation limits yield potential, possibly from non-N limiting factors such as weed, disease or pathogen pressure.

Objectives

1. To determine if the maximum yield potential of rice under prolonged straw incorporation has been impaired.
2. To assess if the severity of weeds is a possible cause of a lower maximum yield in rice fields under prolonged straw incorporation.

Description
A rice residue management study was initiated in 1993 at Maxwell, CA, which terminated in 2001. Main plot treatment included winter flooding and no winter flooding. Subplot treatments included straw baling, burning, incorporating or rolling followed by incorporation. Individual plots measured approximately 2 acres. Grain and straw yield was measured and an N fertilizer rate trial was carried out in the last 4 years of the experiment.

Results And Conclusions
N fertilization and straw management
For all the years, grain yield was strongly affected by N application, independent of straw management and, on average, yield increased by 50 % following an N application of 100 lbs N per acre. When straw was incorporated, grain yield was higher when no N fertilizer was applied compared to the zero N yield when the residue was removed (Fig. 1). Furthermore, the maximum yield was observed when 100 lbs N per acre was applied and

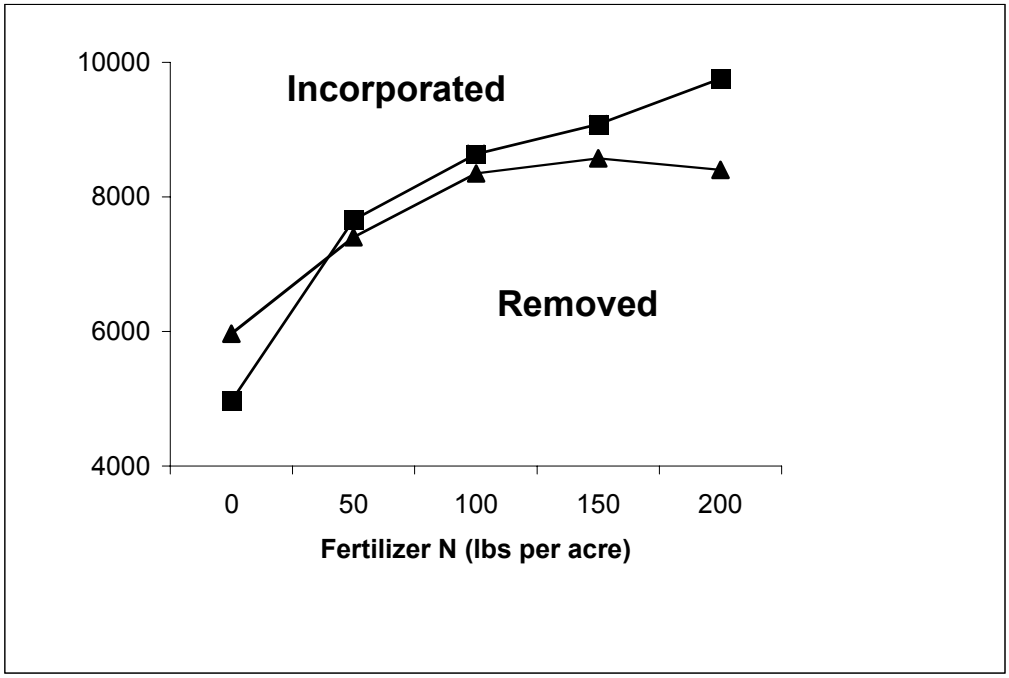

Fig. 1. Yield response of rice following N fertilizer following straw removal or incorporation.

Straw was incorporated, whereas the highest yield was observed when 200 lbs of N per acre was applied and straw was removed. Moreover, the maximum yield observed when straw was removed was higher than when straw was incorporated (Fig. 1). Apparently, a non-N effect occurred and its negative effect on yield was

more pronounced when straw was incorporated. A similar yield response to straw management practices has been observed earlier in the Valley.

Occurrence of weeds and straw incorporation.

Changes in agronomic practices that impact crop yield often take up to 10 years or longer before they are realized. Furthermore, the direction of change, positive or negative, is difficult to ascertain during the transition to alternative practices such as from burning to straw incorporation. In addition, changes in soil fertility often affect other soil properties ranging from physiological stress from nutrient sufficiencies or deficiencies, to plant competitive responses to weeds and pathogens. These potential broad changes in soil properties often make diagnosing factors affecting yield potential problematic.

As part of the fertilizer N rate trials and rice yield determination done in 2001, we determined the severity of water grass under a wide range of N fertilizer application rates and long-term straw incorporation and burning. Only water grass was a problem in 2001, most likely because of large amounts of herbicide used to control a serious total weed problem. Water grass was the main weed to escape the efficacy of the herbicide formulations used. Also, no significant stem rust was found. Weeds and diseases are the most likely non-N factors that limit plant production. Figure 2 shows the incidence of water grass at the Maxwell site in 2001. The burned treatment had considerably no water grass compared to winter flooded and incorporated straw treatments. When the field was not winter-flooded, the burning did not fully suppress the weed population (data not shown). An increase in fertilizer-N increased the incidence of water grass.

Based on our previous research, other factors besides N are likely involved in controlling maximum yield potential. Possible yield-controlling factors that have to be investigated are weed and pests. It is often observed that the incorporation of residues leads to an increase in weed and disease pressure.

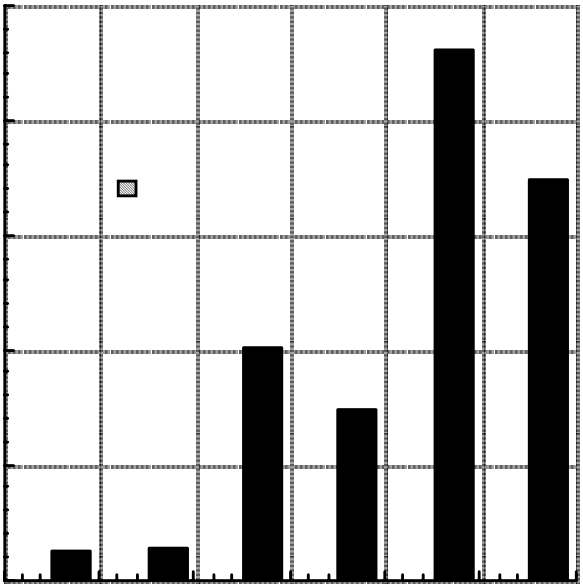

Figure 2. The incidence of water grass in the winter flooded burned (WFBurn) and incorporated (WFInc) treatments.